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Robot Technology Impact on Dyslexic Students' English Learning

Khaled Hamdan, Abid Amorri, Fatima Hamdan

***Abstract*—**Involving students in English language learning process and achieving an adequate English language proficiency in the target language can be a great challenge for both teachers and students. This can prove even a far greater challenge to engage students with special needs (Dyslexia) if they have physical impairment and inadequate mastery of basic communicative language competence/proficiency in the target language. From this perspective, technology like robots can probably be used to enhance learning process for the special needs students who have extensive communication needs, who face continuous struggle to interact with their peers and teachers and meet academic requirements. Robots, precisely NAO, can probably provide them with the perfect opportunity to practice social and communication skills, and meet their English academic requirements. This research paper aims to identify to what extent robots can be used to improve students' social interaction and communication skills and to understand the potential for robotics-based education in motivating and engaging UAEU dyslexic students to meet university requirements. To reach this end, the paper will explore several factors that come into play – Motion Level-involving cognitive activities, Interaction Level-involving language processing, Behavior Level -establishing a close relationship with the robot and Appraisal Level- focusing on dyslexia students' achievement in the target language.

***Keywords*—**Dyslexia, robot technology, motion, interaction, behavior and appraisal levels, social and communication skills.

I. Introduction

THE number of disabled people in the world is soaring up exponentially [1]. The World Health Organization mentioned that around 10% of the world's population has been identified with some kind of disability. In the USA, about 14% of the population suffers from disabilities [2]. According to the forecast in Europe at least 18% of the population will be disabled during the next 20 years. As a result, there is an urgent need for governments worldwide to pay great attention to this serious education issue by offering adequate funding and appropriate learning services. An overwhelming majority – 95% – of teachers and education professionals in different countries surveyed believed specific funding for dyslexia students' education should be allocated. Language teachers believe that this would have a positive impact to provide a better learning environment for dyslexics.

However, there is unfortunately, limited statistical information about people with disabilities in the Arab countries. A recent study conducted by Al Gain and Al-Abdulwahab [3], estimates that 3.73% of Saudis have functional disabilities and approximately 13% of the U.A.E population suffers from disabilities [2]. At U.A.E University, there are around 50 cases of physical and mental disabilities. Confronted by this problem, U.A.E higher education officials have made considerable endeavors to equip university with special needs centers, iPads and most recently with robots to clearly show its total commitment and tackle this intricate pedagogical issue most effectively.

It is worth pointing out that the U.A.E Ministry of Higher education identifies dyslexic students at the beginning of each academic year in order to put them in special classes, allocate special needs' centers and robots to cater for their needs. Finally, it appoints experienced teachers to provide them with the most suitable learning environment. UAE University instructors, from their part, looked for new teaching strategies, which relied on iPads applications and features to teach English language, and most recently, they introduced robots in workshops/ tutorial sessions in order to engage dyslexia students in the learning process. The students who have complex communication needs, require to be strongly engaged in effective learning process in order to ultimately cater for their immediate social and deferred communicative needs.

Dyslexia as a disability, is often confusing for both parents and teachers, as the manner in which it presents itself, it can differ widely among students, although it cannot go undetected for long time in the early stages at primary or secondary schools. Dyslexia students seemed to be lagging behind normal students in terms of proficiency in the four macro-skills. The sooner dyslexia is detected, the better the outcome will be, because once the students fall behind, their learning problems connected with reading, listening, writing, and spelling can become complicated by showing adverse side effects.

The focus on dyslexic students learning then stems from a widespread belief that they often face challenges with reading, fine motor skills, for example speak and write with a pen. By using technological learning devices like the robot, the dyslexia students' tutorial sessions can make English learning a lot easier for them to grasp, as it increases the chances of improving the level of oral interaction, reading and writing skills proficiency. It helps bring them closer to normal students' intellectual and linguistic levels. In addition, special needs students suffer from genetic or environmental factors as a result of factors acquired from lack of ability to learn or gain experience or skills, while dyslexia, is also known as reading disorder, which is characterized by trouble with reading despite normal intelligence [4]. Besides, students who have a language processing disability, have weakness in one or more areas of language-decoding, encoding, phonological

Khaled Hamdan, Abid Amorri and Fatima Hamdan are with University College - UAE University, UAE (e-mail: khamdan@uaeu.ac.ae).

awareness, word retrieval and syntax [9].

II. Characteristics of Dyslexia

Dyslexia is a disorder related to problems with the visual notation of speech and with alphabet writing systems, which have a phonetic construction [4], [5]. The most salient features of dyslexia have been pointed out essentially from miscellaneous languages research related to systems of writing namely English language. However, many of these characteristics may be transferable to other language systems. The causes of dyslexia are still unknown accurately, although experts believe that dyslexia is a phonological disorder in processing words. Dyslexic students have tremendous reading problems because they cannot see or hear a word, or break it down to discrete sounds and then associate each sound with letter/s that makes up the word. Some researchers believe that some dyslexics have visual problems in addition to difficulties to process phonemes. In any case, there is no evidence that dyslexics literally "see" letters backward or in reverse order within words. However, most dyslexic students show a low performance despite having normal cognitive abilities and do not suffer from any seeing or hearing or physical disabilities. These idiosyncrasies do not necessarily appear in all dyslexic students [4].

The impact that dyslexia is different for each person, depending on the severity of the condition and the approaches of the remediation. The most common effects are problems with reading, speaking, spelling, listening and writing. Some dyslexics do not have much difficulty with early reading and spelling tasks, but do experience great problems when more complex language skills are required, such as grammar, understanding textbook material, and writing essays [6].

Learning difficulties can be both Mental Development Difficulties and Academic Learning Difficulties.

A. Mental Development Difficulties

The characteristics of a dyslexic student's behaviour, before attending school, can be seen through a lack of attention, a lack of realization to solve problems difficulty of concepts acquisition and memorization. If they diagnose them on time, dyslexia problems will be successfully from early stages [4].

B. Academic Learning Difficulties

Useless to say that dyslexic students have long suffered from this huge handicap, which prevented them from acquiring a reasonable competence in target language, i.e. accuracy and fluency in the mastery of language skills. This can be seen mainly in the early stages of school learning in areas like mathematics calculation and in language macro-skills–speaking, listening, writing, spelling and reading.

Skills: speaking, listening, writing, spelling and reading.

1. Speaking and Listening Skills Difficulties

The speech or hearing deficits that dyslexic students show, can be summed up in the confusion of words meanings such as before/after, right/left, difficulty learning the alphabet, naming problems. In addition, the speech or hearing deficits can be seen in the identification or words generating, or word syllables counting, sounds hearing and manipulating words (awareness of phonemes). Furthermore, it can be through distinguishing different sounds in words (hearing discrimination), learning the sounds of letters (in alphabetic writing systems). Besides, it can be perceived through associating individual words with their correct meanings, time keeping and concept of time, confusing combinations of words, and organizing skills. For phonological awareness skills, some dyslexia students have difficulty recognizing or reproducing rhyming words, isolating sounds in beginning, final, and/or medial position, and segmenting individual sounds in words.

Regarding the use of alphabet, dyslexia students have difficulty learning or recalling names of letters, and learning or recalling sounds of letters. Concerning word recognition and utterance, they have difficulty pronouncing unfamiliar words and reading words in isolation. As far as fluency is concerned, they stammer in reading material at an expected rate. In spelling, they have difficulty memorizing words for spelling tests and in context. Finally, they have difficulty constructing sentences, appropriate written compositions and producing sufficient written output. As for oral language, when listening, they have difficulty understanding verbal directions and stories read to them.

In speaking, they have difficulty acquiring new oral vocabulary, finding the right word, uttering grammatically correct sentences, and explaining ideas or elaborating on thoughts. Concerning attention, they display difficulty organizing time and materials, and easily distracted by sights or sounds, many things happening too quickly. They are often overactive and inconsistent with the production of class work and homework assignments. Finally, they have difficulty with handwriting and copying tasks and display poor handwriting quality on written assignments.

2. Reading and Spelling Skills Difficulties

Spelling errors occur because of difficulty learning letter-sound correspondences. Dyslexic students might tend to misspell words, or leave vowels out of words. In addition, letter order seems to pose a serious problem to them because they may also reverse the order of two letters especially when the final, incorrect word looks similar to the intended word (e.g., spelling "fales" instead of "false"). Furthermore, letter addition/subtraction is another serious issue, as they may perceive a word with letters added, subtracted, or repeated. This can lead to confusion between two words containing most of the same letters. Students with dyslexia also commonly spell words inconsistently, but in a highly phonetic form such as writing "shud" for "should". They also typically have difficulty distinguishing between homophones such as "their" and "there". Other examples of these issues can be seen in the difficulty in reading full sentences, correctly articulating letters, mixing up sounds in multi-syllabic words (ex: Aminal for Animal, Bisghetti for Spaghetti, Hekalopter for Helicopter, hangaberg for hamburger, etc.), problems of immature speech "wed and gween" instead of "red and green" [3].

3. Writing Difficulties

Dyslexia students may have difficulty with handwriting because of literacy problems. This shows poor handwriting, characterized by irregular slower writing speed than average or by the inability to write straight on a piece of paper with no guidelines. Some studies revealed that dyslexia difficulty involves motor skills disorder. This difficulty is shown in poor gesture coordination [7].

III. Rationale for Using a Robot as a Teaching Aid?

For a few years, Mobile learning technology using iPad different applications and features has played an important role in education and mainly for special needs students. Lately, teachers used another technology device in special needs education i.e. the introduction of Robot technology in order to cater for disabled students' social and communicative needs. There are many reasons for choosing Nao Robot in dyslexia classes [10]. First, it is an appropriate and helpful technology device, as it helps dyslexia students learn more easily, because it is interactive, fun and slow enough to suit their learning speed. It also engages them in mental information processing and captures their attention. In addition, it is adaptive to the needs of the dyslexia classroom from individuals to groups. Finally, it is accessible to every profile of users as it enables student-personalized lessons. In fact, Nao is also a great help for teachers who really appreciate eliminating monotonous tasks, as it cuts down on routine paperwork to bring focus back to the dyslexia students. As stated earlier in this paper, the main focus is the use of Nao robot to help dyslexic students cope with 4 major skills difficulties, i.e. reading (spelling) and writing, speaking and listening. Activities dealt with in tutorial sessions will involve:

A. Motion Level

It involves cognitive activities.

B. Interactional Level

It involves language processing and social interaction.

C. Behavioral Level

It establishes a close relationship between the dyslexic student and the robot.

D. Appraisal Level

It focuses on evaluating the robot impact on dyslexic students' behavior, on his English language learning process and on the teacher's delivery/ teaching strategy adopted to achieve his objectives and goals in workshops/ the tutoring sessions. To improve dyslexics' English language learning and understand the skills they require, instructors tailor interactive robotics-based tutorials according to their appropriate levels. [8], [11]. These tutorials will introduce them to their daily life/university environment so they can be more self-dependent, be able to initiate and complete their daily academic tasks rather than constantly rely on their English instructor. In addition, these tutorials ensure that the students receive a fair education in the basic concepts in order to improve their thinking, reading, writing, speaking and spelling skills. Some of the topics of these robots tutorials include situations/settings and their corresponding language rhetorical functions. Students interact with the pre-programmed robot Nao through a dialogue about different situations, using a set of rhetorical language functions related to specific topics to communicate in the target language in form of meaningful sentences (As shown in Fig 2). Tables I and II summarize robot activities used to improve dyslexic students' listening and speaking, reading and spelling, and writing skills.

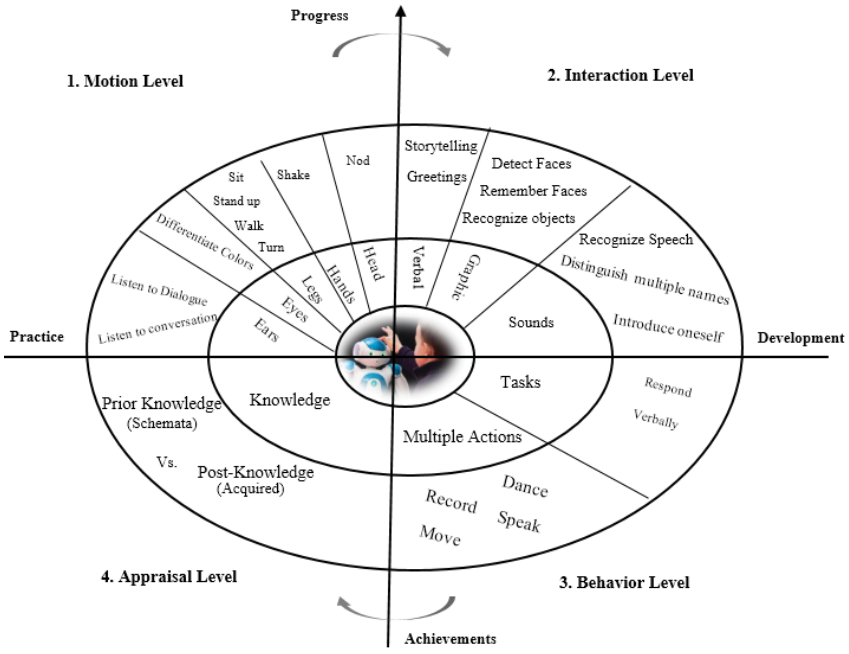


Fig. 1 Robot Learning Process Levels

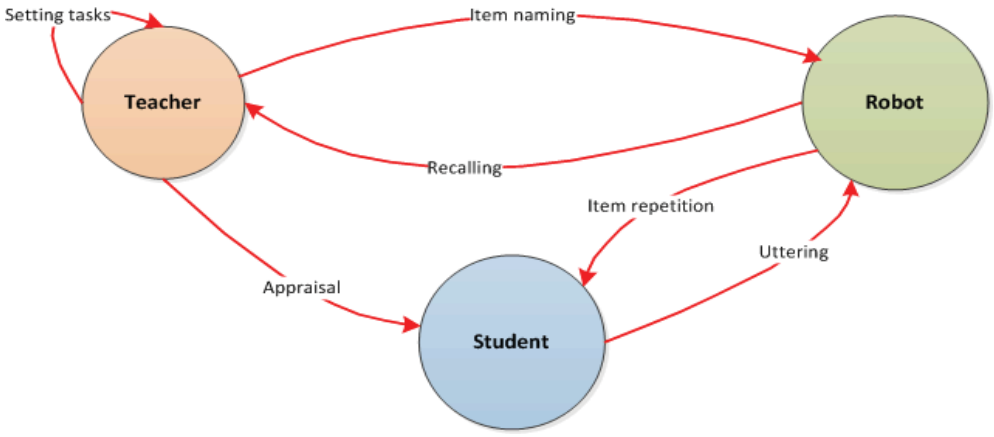
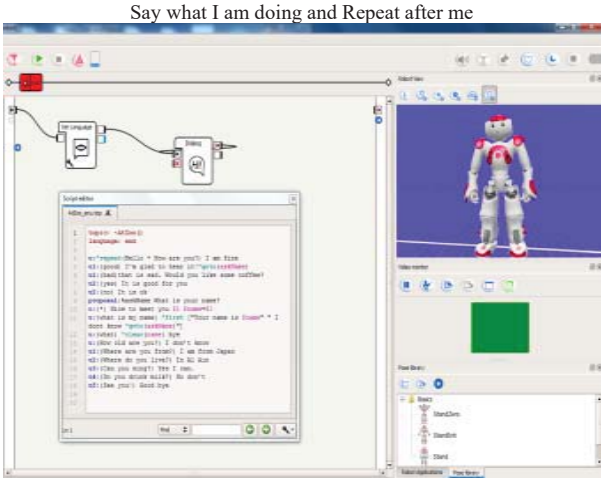
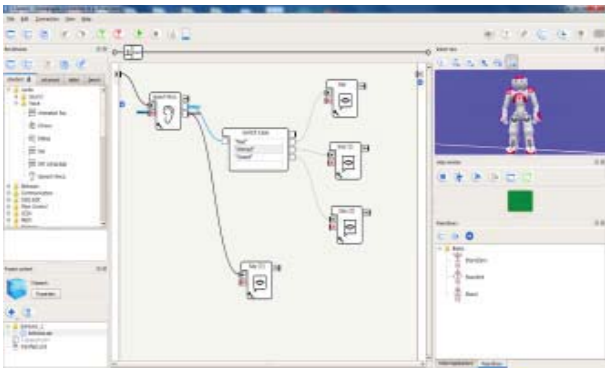
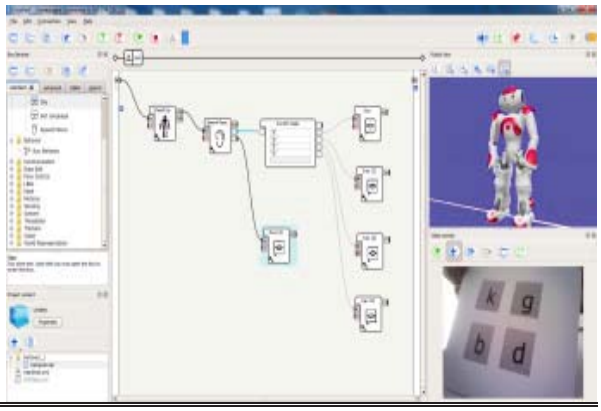


Fig. 2 Item Identifications States

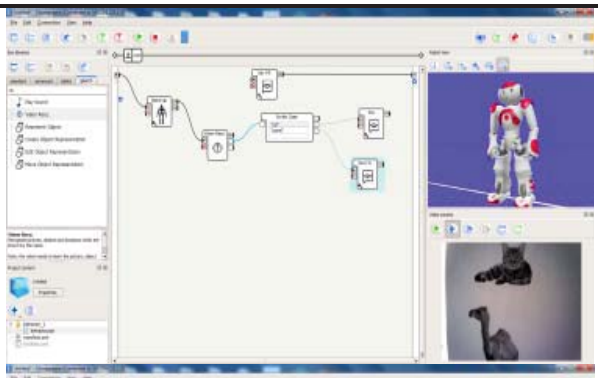
TABLE I
SITUATIONS TOPICS AND CORRESPONDING RHETORICAL LANGUAGE FUNCTIONS SUPPORTING TUTORIAL ACTIVITIES

		Rhetorical Language Functions
	A. Situations	**Illustrations**
Motion Level	At the Zoo	• Identifying animals by pictures • Comparing animals • Ordering animals (by size and type)
	At the Restaurant	• Asking for the menu • Paying the bill
	At University	• Finding Departments • Finding Learning Facilities (Tutorial Centre, Speaking Centre, Library)
	At Home	• Finding Rooms • Describing family members/relationships
		Rhetorical Language Functions
	B. Using Interactional Expressions	**Illustrations**
Interactional Level	Greetings	• Saying hello • Saying Hi • Saying Welcome • Saying Goodbye
	Expressing agreement	• That's so true • That's for sure • You're absolutely right • Absolutely • That's exactly how I feel • Exactly
	Expressing Disagreement	• I do not think so. • No way. • Not necessarily. • That is not always true. • No, I'm not so sure about that
	Introducing Oneself	• May I know your name? • How old are you? • Where are you from? • Where do you live?
	Asking for Information	• Can you tell me? • I would like to know • Could you give me
	Using Transportation Systems	• Matching pictures to names, • Using means of transportation, • Asking for information.
		Rhetorical Language Functions
	C. Performing Multiple Tasks	**Illustrations**
Behavioral Level		• Practice dialogue • Washing your hands, • Taking breakfast, • Taking the bus

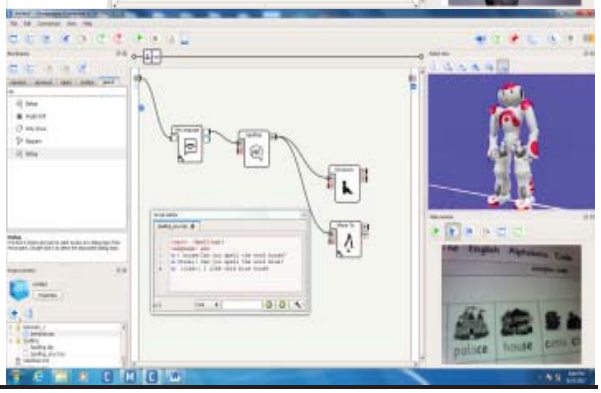
TABLE II
TUTORIAL SESSIONS INVOLVING SITUATIONS TOPICS AND THEIR CORRESPONDING RHETORICAL LANGUAGE FUNCTIONS

	Using Interactional Expressions	
	Activities: Using Visual Memory	**Robot Illustrations**: Say what I am doing and Repeat after me 
	Robot items learning **Label objects by Size or Color** • What is the name of this animal? An elephant. • What color is this animal? Brown. • Is this animal small or big? Very big. • Where can you see it? At the Zoo. E.g., this brown elephant is very big!	
Using interaction expressions	**Greetings** • How are you? Fine thanks • Hello! Hi • What is your name? I am Nao • How old are you? I don't know • Where are you from? Japan • Where do you live? In Al Ain. • Can you sing? Yes, I can. • Do you drink milk? No I don't • See you! Good bye	**Robot Illustrations** 
Forming Multiple Tasks	**Identifying Sequence of letters** • Distinguishing letters • Referring letters to pictures - b & d - g & d	**Robot Illustrations** 

Visual differentiation
Cat / Camel



Spelling Weakness
Can you spell the words
Blue, House



IV. Conclusion

To evaluate the impact of robots as a teaching aid in workshops and tutorial sessions, it became conspicuous that Nao robot was an effective tool in the special needs education. Robots fascinate dyslexia students, as they capture their imagination. They became less reluctant to interact with a robot and physically more active, capable of overcoming some of their language skills deficiencies in reading, writing, speaking and listening, and to a certain extent, become somehow capable of acquiring the same English language competence as normal students. As for teachers, they can use Nao robots to reflect on, evaluate and tailor their current teaching course, objectives and goals and teaching strategies so that their instruction becomes the best possible for dyslexia students equal to that of normal students.

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